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GROWTH AND DYNAMICS OF TILAPIAS IN EDKU LAKE, EGYPT

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Key words: Tilapias, Growth, Dynamics.

ABSTRACT

Growth as well as mortality and exploitation rates have been investigated for the different populations of tilapia inhabiting Lake Edku. Fish samples were obtained from experimental fishing operated in the lake using monofilament trammel nets with different mesh sizes. The results obtained showed that ***Oreochromis niloticus*** and ***Sarotherodon galilaeus*** *are faster growing species as compared with the other two species namely,* ***Oreochromis aureus*** and ***Tilapia zillii.*** *The index of overall growth performance was found to be 2.38 for* ***O. niloticus****, 2.33 for* ***S. galilaeus****, 2.20 for* ***O. aureus*** *and 2.15 for* ***T. zillii.*** *The predominance of small sized fish individuals was also noticed since age group II constituted the main bulk of the catch contributing 64.24%, 59.85%, 77.88% and 79.42% of the catch of* ***O. niloticus, O. aureus, T. zillii*** and ***S. galilaeus*** *respectively. The older age groups are represented in small proportions or even absent in some cases reflecting the higher levels of mortality and overexploitation that tilapias suffer in the lake.* ***O. niloticus*** *is the only species which is moderately exploited while the other tilapias are overexploited on different levels. The rate of exploitation (E) amounted to 42.12% for* ***O. niloticus****, 50.17% for* ***O. aureus****, 55.60% for* ***T. zillii*** *and 62.19% for* ***S. galilaeus****. In fact, we are in front of a prominent state of overfishing in Lake Edku that could be encountered either by minimizing the fishing effort or by suggesting an appropriate mesh size of the fishing gear used. The results of yield estimates*

revealed that fish individuals less than 3.2 years for ***O. niloticus****, 3.4 years for* ***O. aureus****, 3.3 years for* ***S. galilaeus*** *and 3.4 years for* ***T. zillii*** *are overfished at any level of fishing mortality and hence they must be avoided in fishing operations.*

INTRODUCTION

Tilapias are the most popular fish in Egypt being common in River Nile and its branches, Lake Nasser and the brackish coastal Delta lakes constituting about 70% of the total Egyptian fish production (El-Zarka, 1956). These fishes are also known in Syria, Jordan and South East Asia beside their wide distribution in Africa and tropical America. In fact, a series of extensive studies had been made on the biology and fishery of tilapias in the different Egyptian inland waters of which we could review Elster and Jensen (1960), El-Zarka (1961), Shaheen (1969), El-Zarka ***et al.*** (1970), Abdel-Malek (1972), Al-Kholy and Abdel-Malek (1972), El-Maghraby ***et al.*** (1972), Latif and Rashid (1972), Bishara (1973), Latif and Saady (1973), Abdel-Azim (1974), Talaat (1979), Payne and Collinson (1983), Hussein (1984), Ishak ***et al.*** (1985), Hosny (1987), Akel (1989), Abdel-Aziz ***et al.*** (1990), Al-Haweet (1991) and Abd-Alla (1995).

In spite of the great economic importance of tilapias in Lake Edku particularly after the gradual disappearance of marine fishes from the lake fisheries, yet few studies (Talaat, 1979; Abdel-Aziz ***et al.***, 1990 and Abd-Alla, 1995) have been made on tilapias from this lake. Thus, the present study is an endeavour to fill this gap and to throw light on growth, mortality and rate of exploitation for the different populations of tilapia in Lake Edku, which could be essential for the management and development for such valuable fisheries resource.

It is worth to mention that this study is a part of the first phase of the research plan of Fisheries Division belonging to National Institute of Oceanography and Fisheries which is proposed to last for 3 years. The aim of this plan is to develop the fisheries in the northern Delta lakes namely, Manzala, Borollus, Edku and Mariut.

MATERIAL AND METHODS

Lake Edku is a shallow water depression with depth ranging between 0.40 and 1.00 meter. The lake is situated at the western margin of the Nile Delta and connected with the Mediterranean Sea, at its western extremity, through Boughaz El-Maadia (Fig. 1). It is the smallest one of the four Northern Delta lakes since it covers about 17,000 feddans.

Fish samples were obtained from experimental fishing operated in the lake throughout the period from November 1999 to March 2001. Sampling was done twice weekly using monofilament trammel nets with stretched mesh size ranging from 3.33cm to 5.58cm.

The total catch of experimental fishing operations contained 3867, 2488, 2125 and 554 fish specimens of ***Oreochromis niloticus***, ***Oreochromis aureus***, ***Tilapia zillii*** and ***Sarotherodon galilaeus*** respectively. For every fish specimen, the total length to the nearest 0.1cm and the total weight to the nearest gm were measured and scales were collected from the flank region on the left side and below the lateral line.

The scales were examined, using a binocular microscope with an eye piece micrometer, and age was determined by counting the number of completely developed annual rings.

The instantaneous total mortality coefficient (Z) was obtained using the catch curve (Ricker, 1975) by taking the slope of the descending portion of the curve. The natural mortality (M) was estimated according to Pauly (1980). The fishing mortality (F) was calculated by substituting the values of 'Z' and 'M' in the equation: $Z = M + F$. The expectation of death due to fishing or what is known as the rate of exploitation (E) was estimated according to Cushing (1968) where $E = F(1-e^{-Z})/Z$.

Yield equation, as developed by Beverton and Holt (1957), is usually used to estimate yield as a function of age and fishing mortality. The equation was applied in the present study at a fixed level of fishing mortality (0.01) representing the lowest possible mortality level so as to determine the minimum appropriate age of the fish, which could be retained in the fishing gear.

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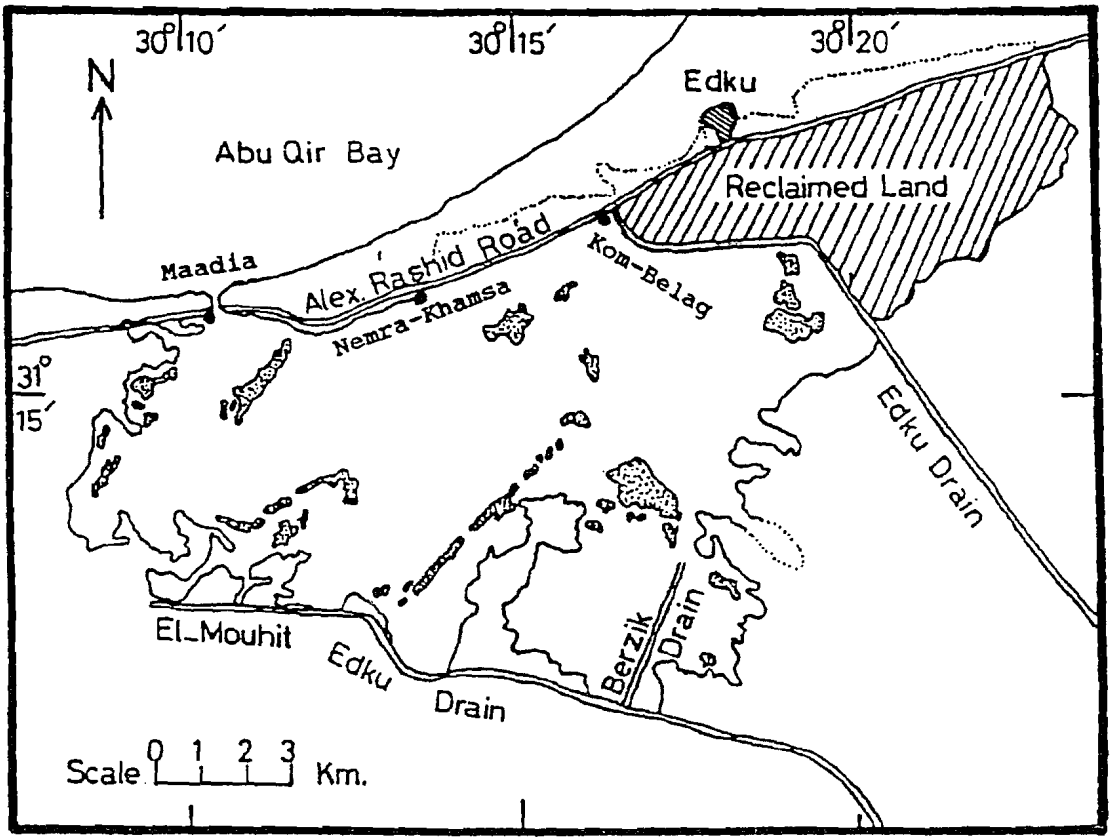

Fig. (1): Map of Lake Edku

RESULTS

Growth:

The length at the end of each year of life and the annual increment in length for the different tilapia species are shown in Table (1) from which it is noticed that the maximum value of annual increment is attained at the end of the first year of life, for all tilapias, after which the increment tends to decrease gradually as the fish gets older. The annual increment in length at the end of the first year amounts to 9.11 cm, 8.58 cm, 7.37 cm and 6.74 cm for ***O. niloticus, S. galilaeus, O. aureus*** and ***T. zillii*** respectively. From the same table it is also noticed that ***O. niloticus*** grows relatively faster as compared with the other tilapias while the lowest growth rate is observed in ***T. zillii.***

The theoretical growth as obtained from von Bertalanffy growth parameters fits the growth calculated from the scale readings. The growth parameters for the different tilapias were found to be as follows:

	L_∞	K	t_o
O. niloticus	34.5	0.2015	-0.5209
S. galilaeus	28.1	0.2695	-0.3526
O. aureus	27.4	0.2104	-0.4880
T. zillii	22.5	0.2659	-0.3386

The length-weight relationship for the different tilapias in the lake was deduced according to the power equation $W = aL^b$. The length-weight relations were found to be as following:

O. niloticus	$W = 0.01702\ L^{3.03264}$
S. galilaeus	$W = 0.01727\ L^{3.04138}$
O. aureus	$W = 0.03260\ L^{2.75284}$
T. zillii	$W = 0.04005\ L^{2.68754}$

The above-mentioned length-weight relations were applied to convert the growth in length into the corresponding growth in weight. Table (2) shows the weights at the end of the different years of life and the annual increment in weight for the different tilapias inhabiting the lake. From the table it is noticed that the lowest increment occurs at the

Table (1): Calculated length (cm) and increment at the different years of life of tilapias in Lake Edku. (increments in brackets)

Species	*Years of life*						
	1	*2*	*3*	*4*	*5*	*6*	*7*
O. niloticus	9.11 (9.11)	13.74 (4.63)	17.53 (3.79)	20.63 (3.10)	23.16 (2.53)	25.25 (2.09)	27.06 (1.81)
O. aureus	7.37 (7.37)	11.17 (3.80)	14.25 (3.08)	16.74 (2.49)	18.75 (2.01)	20.45 (1.70)	
T. zillii	6.74 (6.74)	10.42 (3.68)	13.24 (2.82)	15.35 2.11)	17.06 (1.71)		
S. galilaeus	8.58 (8.58)	13.19 (4.61)	16.72 (3.53)	(2.69)			

Table (2): Calculated weight (gm) and increment at the different years of life of tilapias in Lake Edku. (increments in brackets)

Species	*Years of life*						
	1	**2**	**3**	**4**	**5**	**6**	**7**
O. niloticus	13.83 (13.83)	48.09 (34.26)	100.67 (52.58)	164.95 (64.28)	234.27 (69.32)	304.45 (70.18)	375.57 (71.12)
O. aureus	7.97 (7.97)	25.02 (17.05)	48.92 (23.90)	76.21 (27.29)	104.13 (27.92)	132.24 (28.11)	
T. zillii	6.76 (6.76)	21.79 (15.03)	41.47 (19.68)	61.70 (20.23)	81.96 (20.26)		
S. galilaeus	11.92 (11.92)	44.09 (32.17)	90.70 (46.61)	142.78 (52.08)			

end of the first year. Then the increment increases gradually until it reaches its maximum value at the end of the oldest age. The results showed also that the rate of growth in weight of both ***O. niloticus*** and ***S. galilaeus*** is much higher than that of ***O. aureus*** and ***T. zillii***. The weights at the end of the first year of life for the different tilapias were found to be 13.83 gm for ***O. niloticus***, 7.97 gm for ***O. aureus***, 6.76 gm for ***T. zillii***, and 11.92 gm for ***S. galilaeus***.

Age distribution:

Age distribution beside giving a picture on age structure of fish populations, it is also used as an indication to the mortality and survival rate. However, the determination of the actual age structure necessitates a type of gear that captures all age groups as in their natural proportions. But since it is often difficult to perform such fishing practically, the representative samples of the catch of experimental fishing as well as the commercial catch could be considered the best available way in this concern.

Age construction of the catch of the four species studied is shown in Table (3) from which it is generally noticed that the number of age groups, constituting the age structure, varies from one species to another. Thus, the catch of ***O. niloticus*** contains 7 age groups from 1^- to 7^- and that of ***O. aureus*** constitutes 6 age groups from 1^- to 6^- while 5 age groups characterize the catch of ***T. zillii***. The least number of age groups is noticed in ***S. galilaeus*** where the catch consists only of 4 age groups from 1^- to 4^-. From the table it is also evident that age group 2^- dominated the catch for all tilapias contributing 64.24%, 59.85%, 77.88% and 79.42% for ***O. niloticus, O. aureus, T. zillii*** and ***S. galilaeus*** respectively. The other age groups are represented in different proportions according to the species. A slight decrease is noticed in the proportions from age group 2^- to age group 7^- in case of O. niloticus reflecting the relatively lower mortality rate occurred. For ***S. galilaeus***, a sharp decline in the percentage occurrence is noticed from age group 2^- to age group 4^- indicating the higher mortality in this species. In respect of the other two species, ***O. aureus and T. zillii,*** a decrease is also observed in the proportions from age group 2^- to age group 6^- for the former species and from age group 2^- to age group 5^- for the latter species, but this decrease is relatively slight as compared with S. galilaeus.

Mortalities and rate of exploitation:

The levels of mortality and rate of exploitation for the different tilapias are shown in Table (4). From the table it is evident that the instantaneous total mortality coefficient (Z) and the annual mortality rate (A) show the highest values in case of ***S. galilaeus*** (Z = 2.1475; A = 88.32%) followed by ***T. zillii***

Table (3): Age distribution of different tilapias in Lake Edku.

Age group	*O. niloticus*		*O. aureus*		*T. zillii*		*S. galilaeus*	
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
1⁻	481	12.44	64	2.57	68	3.20	18	3.25
2⁻	2484	64.24	1489	59.85	1655	77.88	440	79.42
3⁻	731	18.90	844	33.92	339	15.95	90	16.25
4⁻	106	2.74	80	3.22	58	2.73	6	1.08
5⁻	51	1.32	9	0.36	5	0.24		
6⁻	12	0.31	2	0.08				
7⁻	2	0.05						
Total	**3867**		**2488**		**2125**		**554**	

Table (4): Levels of mortality, survival and exploitation rate for the different tilapias in Lake Edku.

Species	*Z*	*F*	*M*	*S*	*A*	*%V*	*%E*
O. niloticus	1.3909	0.7799	0.6110	0.2489	0.7511	32.99	42.12
O. aureus	1.7766	1.0729	0.7037	0.1692	0.8308	32.91	50.17
T. zillii	1.9172	1.2497	0.6675	0.1470	0.8530	29.70	55.60
S. galilaeus	2.1475	1.5121	0.6354	0.1168	0.8832	26.13	62.19

Z = Instantaneous total mortality coefficient.
F = Fishing mortality.
M = Natural mortality.
S = Survival rate.
A = Annual mortality rate.
E = Exploitation rate.
V = Deaths due to natural causes.

(Z = 1.9172; A = 85.30%) and ***O. aureus*** (Z = 1.7766; A = 83.08%), while the lowest values are noticed in ***O. niloticus*** where Z = 1.3909 and A = 75.11%. The survival rate (S) exhibits a reverse order since it amounts to 24.89%, 16.92%, 14.70% and 11.68% for ***O. niloticus, O. aureus, T. zillii*** and ***S. galilaeus*** respectively.

Being proportional to total mortalities, the fishing mortality (F) and the rate of exploitation (E) have more or less the same trend of the total mortality coefficient (Z). The highest values are noticed in S. galilaeus where F = 1.5121 and E = 62.19%. ***T. zillii and O. aureus*** come later with F = 1.2497 and E = 55.60% for ***T. zillii*** and F = 1.0729 and E = 50.17% for ***O. aureus***. The lowest values of fishing mortality (F = 0.7799) and rate of exploitation (E = 42.12%) are observed in ***O. niloticus***.

The natural mortality (M) and the expectation of death due to natural causes (V) vary from one species of tilapia to another, but generally they tend to increase with decreasing fishing mortality. The values of natural mortality (M) and the deaths due to natural causes (V) amounted to 0.6110 and 32.99% for ***O. niloticus***; 0.7037 and 32.91% for ***O. aureus***, 0.6675 and 29.70% for ***T. zillii*** and 0.6354 and 26.13% for ***S. galilaeus***.

Yield per recruit estimates:

Yield was obtained as a function of age at a fixed level of fishing mortality, which was chosen in the present study as 0.01 to represent the lowest possible fishing mortality. The results, as noticed from Figure (2), showed that the maximum sustainable yield occurred at the age of 3.2, 3.4, 3.3 and 3.4 years for ***O. niloticus, O. aureus, S. galilaeus*** and ***T. zillii*** respectively. Hence, fish with age less than those mentioned must be avoided in fishing operations in order to gain the best utilization of the stock of tilapia away from intensive fishing or overexploitation.

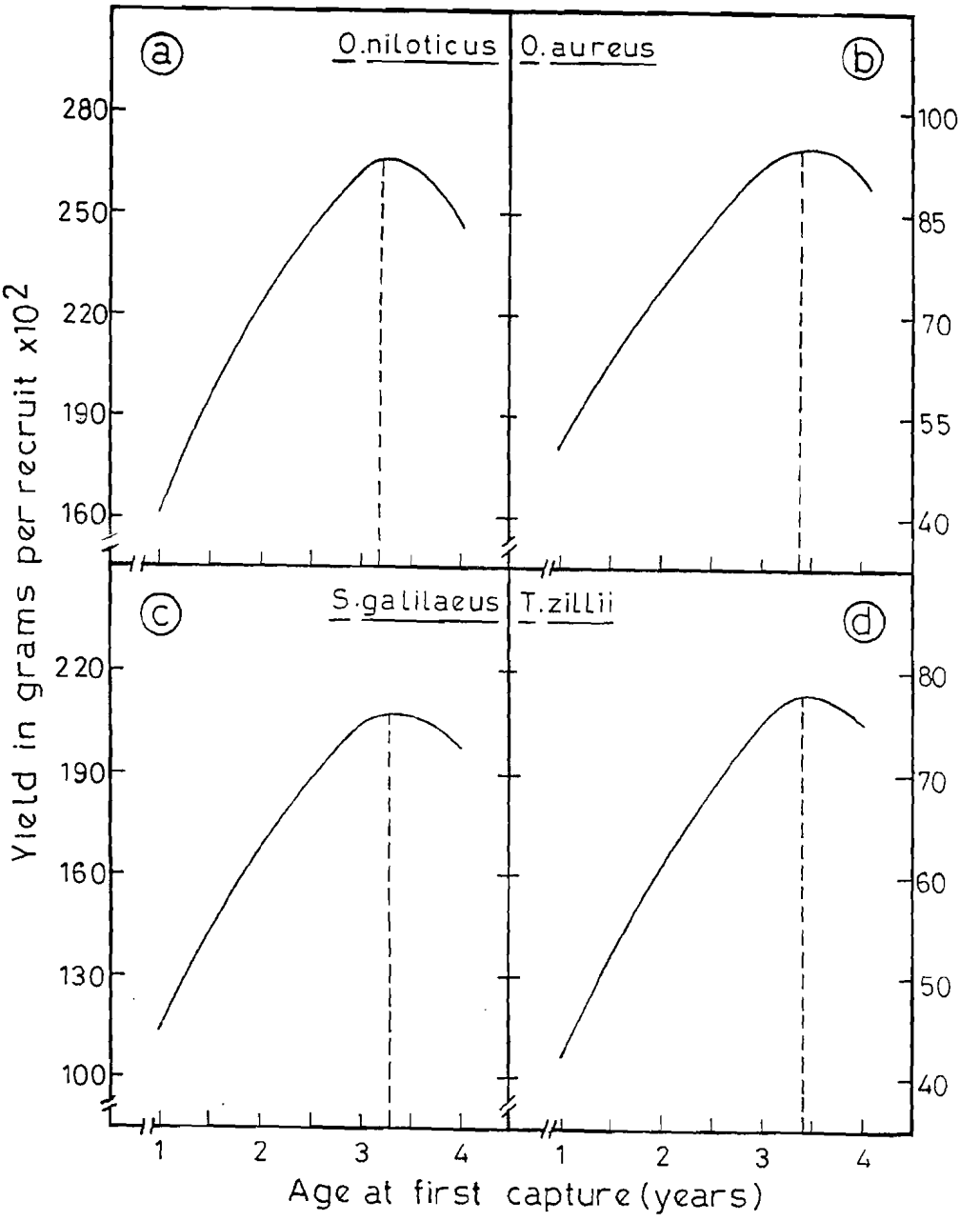

Fig. (2): Yield per recruit by age at a fixed level of fishing mortality (0.01) for the different tilapias in Lake Edku.

DISCUSSION

The study of growth rate of tilapias in Lake Edku revealed that O. niloticus grows faster as compared with the other tilapia species. This was verified by calculating the index of overall growth performance, $\theta = \log K + 2 \log L_\infty$ (Moreau *et al.*, 1986), which was found to be 2.38, 2.33, 2.20 and 2.15 for ***O. niloticus, S. galilaeus, O. aureus*** and ***T. zillii*** respectively. On the other hand, the values of these indices were found higher when compared with a previous study in the same lake. According to Abd-Alla (1995) the indices amounted to 2.25 for ***O. niloticus***, 2.21 for S. galilaeus, 2.15 for ***O. aureus*** and 2.09 for ***T. zillii*** indicating the improvement in the growth performance of ***tilapias*** according to the present data. However, this improvement may probably be attributed to a decrease in competition as a result of the general increase in present rates of exploitation and/or as consequence of the gradual disappearance of marine fishes from the lake fisheries.

Relative higher mortalities and rates of exploitation are noticed in three of the four tilapias. ***O. niloticus*** is the only species which is moderately exploited (E = 42.12%) while the other three species are overexploited on different levels. The rate of exploitation was found to be 62.19% for ***S. galilaeus***, 55.60% for ***T. zillii*** and 50.17% for ***O. aureus***. Thus, it seems that tilapias suffer from intensive fishing which could be encountered either by minimizing the fishing effort or by regulating the size of the fish caught. However, the size regulation is usually preferable since it does not have such drastic effects on the individual fisherman as restricting fishing effort (Gulland, 1978).

Yield per recruit or equilibrium yield curves are of the most common models used for the prescription of the fisheries state of any fish stock. These models depend upon the yield as a function of age and fishing mortality (Beverton and Holt, 1957). Yield estimates could be also used to determine the minimum appropriate age, and subsequently the size, which might be retained by the fishing gears to gain the optimum exploitation of the fish stock. The present results showed that the harvest should start at ages of 3.2 years for ***O. niloticus***, 3.3 years for S. galilaeus and 3.4 years for both ***O. aureus*** and ***T. zillii.*** These ages correspond to fish total length of 15.0 cm, 14.0 cm, 17.5 cm and 18.0 cm for ***O. aureus***, ***T. zillii, S. galilaeus*** and ***O. niloticus*** respectively. But since it is not practical to catch each species at its particular

size, an average size of about 16.0cm is recommended to be the lower limit for harvesting tilapias.

According to Gulland (1978), yield estimates are often not identical but they are always correlated with the steady state of fish populations and the non-collision of other fish species. Abd-Alla (1995) stated that tilapias constituted the main bulk of the fisheries of Lake Edku contributing about 85% of the total fisheries of the lake. Hence, the possibility of absence of competition and predators effect due to the scarcity of species other than tilapias in Lake Edku render the present data rather valid and consistent.

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